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number 12 amounts to only about 0.01 of a magnitude per day, from which it might be inferred that its maximum magnitude was reached after January 5th.

R. F. Sanford.

On the Relative Intensity of the Absorption Lines in a Spectroscopic Binary

Let S and S' be two stars the visible areas of which are A and A'. Let us call i and i' the photometric intensity of the continuous spectrum in the region corresponding to vibrations of period $p_{x+\Delta_x}$ proceeding directly from S and S' unaffected by the absorbing element E, and let us call ie, $i'e'$ the intensity for vibrations of period p_x, after they have been absorbed by E.

When the light of both stars is received on the slit, the total intensity I for vibrations of period $p_{x+\Delta_x}$ will be

$$I = Ai + A'i',$$

while the total intensity I' for vibrations of period p_x, in the case that both stars are at rest with respect to the observer, will be

$$I' = Aie + A'i'e'.$$

Hence the relative intensity of the common absorption line, corresponding to vibrations of period p_x, as compared with the intensity of the continuous spectrum in the neighboring regions, corresponding to vibrations of period $p_{x+\Delta_x}$, will be given by

$$\frac{I'}{I} = \frac{Aie + A'i'e'}{Ai + A'i_1},$$

and putting

$$\frac{Ai}{A'i'} = R,$$

$$\frac{I'}{I} = \frac{Re + e'}{R + 1} \qquad (1)$$

What the ratio must be in order to show a definite absorption line is a matter of photographic technique, depending on many material factors; it seems, however, that $I'/I = 9/10$, or any smaller value, may suffice.

If the two stars are moving with respect to the observer, with relative velocities v and v', the vibrations absorbed will not arrive with the same period and therefore they will not occupy the same place in the spectrum; hence the necessity of dealing with them individually

Vibrations of period p_x will arrive at the observer, from S, with relative period $p_x \left(1 \pm \frac{v}{c}\right)$ and from S' with a relative period $p_x \left(1 \pm \frac{v'}{c}\right)$. Hence the total photometric intensity I'_1 in the spectral region corresponding to vibrations of period $p_x \left(1 \pm \frac{v}{c}\right)$, absorption line due to star S, will be Aie coming from S, and $A'i'$ coming from the continuous spectrum of S'; while the total photometric intensity I'_2 in the region corresponding to vibrations of period $p_x \left(1 \pm \frac{v'}{c}\right)$, absorption line due to star S', will be $A'i'e'$, plus Ai coming from the continuous spectrum of S. We shall have then

$$I'_1 = Aie + A'i'$$
$$I'_2 = A'i'e' + Ai$$

When the difference in period of vibrations $p_x \left(1 \pm \frac{v}{c}\right)$ and $p_x \left(1 \pm \frac{v'}{c}\right)$ is enough to separate the lines, the region corresponding to vibrations of relative periods $p_x + \Delta_x \left(1 \pm \frac{v}{c}\right)$ and $p_x + \Delta_x \left(1 \pm \frac{v'}{c}\right)$ will have a total intensity $I' = Ai + A'i'$, due to the fact that vibrations of these periods can reach the observer from both stars.

Hence we shall have for the absorption line due to S

$$\left.\begin{array}{ll} & \dfrac{I'_1}{I} = \dfrac{Aie + A'i'}{Ai + A'i'} = \dfrac{Re + 1}{R + 1} \\ \text{and for } S' & \\ & \dfrac{I'_2}{I} = \dfrac{A'i'e' + Ai}{Ai + A'i'} = \dfrac{R + e'}{R + 1} \end{array}\right\} \qquad (2)$$

From these equations it can be seen that the intensity or rather the visibility of the absorption lines is a function not only of R but also of e and e'.

By comparing equations (1) and (2) it might be possible to deduce some important consequences regarding the existence and brightness of a companion star in cases where the oscillating absorption lines of a spectroscopic binary appear single.

If $R = 2.5$ and $e = e' = \frac{1}{4}$, the relative intensity of the common absorption line would be, according to (1),

$$\frac{I'}{I} = \frac{Re + e'}{R + 1} = \frac{3.5}{14},$$

while the relative intensity of each absorption line separately would be for S

$$\frac{I'_1}{I} = \frac{Re + 1}{R + 1} = \frac{6.5}{14},$$

and for S'

$$\frac{I'_2}{I}=\frac{R+e'}{R+1}=\frac{11}{14},$$

showing that the single absorption line should pass thru periodic changes in its relative intensity, if another component star contributes to the integrated spectrum. These periodic changes in intensity might be possible of measurement, even for the case where the single absorption line due to S' is too weak to be detected.

If $R=1$ and $e=\frac{1}{4}$, $e'=\frac{1}{8}$, we would get

$$\frac{I'}{I}=\frac{Re+e'}{R+1}=\frac{3}{16},$$

and for S

$$\frac{I'_1}{I}=\frac{Re+1}{R+1}=\frac{10}{16},$$

and for S'

$$\frac{I'_2}{I}=\frac{R+e'}{R+1}=\frac{9}{16}.$$

We may study by the same method the case of a single star, a considerable part of which is covered by an absorbing element E, thus reducing to ie the intensity of the vibrations of period p_x. In such a case, the total intensity I for the vibrations of period $p_{x+\Delta x}$, coming unabsorbed from the entire stellar disk, will be given by

$$I=Ai,$$

while the total intensity I' for the vibrations of period p_x, absorbed in the area $A\alpha$ but not elsewhere, will be $I'=Ai\,(1-\alpha)+\alpha\,Aie=Ai\,(1+\alpha e-\alpha)$, and the relative intensity of the absorption line will be $I'/I=1+\alpha\,(e-1)$, giving

$$I'/I=7/10, \text{ for } \alpha=1/2.5 \text{ and } e=\tfrac{1}{4}, \text{ and}$$
$$I'/I=29/32, \text{ for } \alpha=\tfrac{1}{8} \text{ and } e=\tfrac{1}{4}.$$

If instead of having the element E in the area $A\alpha$ only, we should have it all over the surface of the star, in distinct masses moving with different radial velocities, for example v_1, v_2, v_3 in the areas $\alpha_1 A$, $\alpha_2 A$, $\alpha_3 A$, respectively, then we could have different absorption lines due to the same element, their relative intensities being

$$1+\alpha_1\,(e_1-1),\ 1+\alpha_2\,(e_2-1),\ 1+\alpha_3\,(e_3-1),$$

and their positions in the spectrum being a function of v'_1, v'_2, v'_3—a case which was considered, with possible applications to the spectra of novae, in my longer paper in this issue.

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